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FOLLOWING PARALLEL PATHWAYS TO EROSION CONTROL

By Guy C. Fuller[1]

Within a brief 3 years strip cropping has emerged from the shuffle of old and new ideas and become recognized as one of the most efficient and practical means of controlling erosion. Particularly commending it is the fact that it may be applied in every region of the United States.

Strip cropping is being recommended because of its simplicity, its flexibility, and, above all, its economic value to the farmer. It is simple because it involves only a rearrangement of the crops usually grown. It is flexible because of the many ways in which it may be used. The economic value of strip cropping may best be measured by the way in which it is being adopted by the farmers. Large numbers of them are coming to realize that it is indispensable so long as they are dependent upon the soil for their existence.

A Pat Comparison

Strip cropping may be compared with the rations of livestock. The dairyman, by mixing in a little different proportion, the ingredients of his cows' diet, will be rewarded by increased profit. The hog raiser may alter his feeds similarly and be well paid in the form of more economical gains. If this is true of livestock, it is even more true of crops, and the farmer may often increase his net return by the adoption of a strip cropping program.

[1] The author is associate agronomist, Soil Conservation Service.

The crop farmer looks toward his soil rather than his livestock for a living. In some areas he depends upon both, but when he realizes the importance of balancing his cropping system as the livestock feeder balances his rations, he will be on his way toward obtaining the maximum net return.

Management Counts

Not only the diet, but the manner of feeding, is important. Good, prosperous livestock farmers realize that great care in methods of feeding, such as clean feed lots or pastures, proper time of feeding, and thoughtfully adjusted amounts of feed with good clean water are contributing factors toward economical meat production. When farmers exercise equal care in the selection of crops, seed-bed preparation, time of seeding, rates and methods of seeding, greater net returns will be realized.

Strip cropping, in its general application, refers to the production of regular farm crops in relatively long variable-width strips, placed crosswise of the line of slope and approximately on the contour.

Crop Groupings

In all regions, regularly grown crops comprise a list too long to enumerate, but we do find it possible to group them, broadly, in two categories: (1) Close-

(See pictures on pp. 30-31, Strip Cropping from Coast to Coast)

83020—36——1

growing crops, such as wheat, oats, barley, rye, and hay crops; (2) row crops or clean-tilled crops, such as corn, cotton, tobacco, potatoes.

Close-growing crops are regarded as being particularly desirable because—

1. They reduce the speed of flowing water.
2. By reducing the speed of water, cutting action is held to a minimum and silt or soil particles will be deposited or dropped.
3. The slower the movement of water, the greater the absorption by soil.
4. Close-growing crops act as spreaders, preventing concentration.
5. They permit interception and dispersal of raindrops, which checks the beating action of heavy rains. They produce a shading effect, which reduces evaporation during periods of drought.

Crop Combinations

In direct contrast, row or clean-tilled crops afford the least resistance to erosion, making it necessary to use the two types of crops in proper combinations in order to attain desired results.

By alternating strips of close-growing crops with row or clean-tilled crops down a long gentle slope, soil and moisture losses are reduced to a minimum.

Water falling upon the clean-cultivated land will meet with little resistance and will gain momentum as it passes down the slope; therefore, the practice is recommended of placing the crops in variable-width strips crosswise of the line of slope—the width of each strip being determined by the percent of slope, the type of soil, and the crops to be grown. Such a practice is simple, inexpensive, and widely applicable.

Cover for the Land

In view of the data obtained and recognized value of a vegetative cover in a strip-crop system of farming, the ration will not be balanced unless a vegetative cover is provided for the land at all times. Here again we may refer to the list of crops possible to be grown in any given region. In the Southeast winter peas broadcast in a clean-tilled crop, such as cotton, late in the summer will provide an excellent cover during the winter. In other areas, rye, winter wheat, or vetch may be used but wherever possible legumes should receive first consideration.

The addition of more crop residue will materially aid in the balancing of this ration. When worked into the surface soil, residues should not be pulverized or completely broken down into small particles which are easily carried away by moving water. Coarse particles of crop residue, together with rough-tillage practices or seed-bed preparation, will conserve soil and moisture, acting in a manner comparable with that of close-growing crops. The cover crop or crop residue will add organic matter to the soil when plowed under or worked into the soil. Legumes plowed under whenever possible as green manure, will materially improve the soil and conserve moisture.

In other areas, where the land is more broken with varying degrees of slope, and in the more humid regions the construction of terraces on the contour, together with strip cropping, has proved to be an effective practice. Moreover, planting, cultivating, and harvesting on the contour is showing itself to be a cost-cutter in horse- and mule-power and machine operation, because it takes less energy to go around a hill than it does to go up and down a hill.

No doubt modifications of strip cropping will be forthcoming as its use is extended and farmers become more familiar with its operations. But of all the practices, old and new, strip cropping has emerged an important keystone in the arch of erosion control. This is because it is simple, flexible, economical, and widely applicable.

TO CONTROL RUN-OFF WATERS ON COLLEGE FARM

Construction of a complete water-disposal system on approximately 200 acres of Clemson College farm will begin soon as a joint undertaking of the college and Soil Conservation Service.

C. C. C. camp 14 in Pickens County, S. C., will cooperate in developing the project to curb erosion on the college farm.

The camp engineer will supervise the running of terrace lines for Nichols-type terraces. Technical workers of the camp are to plan terrace outlets and channels to dispose of run-off water.

As soon as the plans are completed the college will construct terraces under the supervision of C. S. Patrick, college farm superintendent, R. A. McGinty, acting director of research at Clemson, has announced.

Camp enrollees will build the terrace outlets and channels. Bermuda sod is to be used in the open field and masonry structures in woodland to protect the outlet channels against gullying.

A Practical Demonstration

All of the terraces will be constructed in accordance with specifications which have been worked out for South Carolina by the Soil Conservation Service and the Extension Service.

When completed the water disposal system will give thousands of South Carolina farmers who visit the farm each year an opportunity to observe improved practices for disposing of run-off water from cultivated fields.

MAKING THE CAMERA MORE EFFECTIVE

Photographers that can climb like firemen and bring down picture prizes not available when they keep both feet on the ground make a real contribution to the improvement of Soil Conservation Service pictures.

A little elevation eliminates undesirable foreground and extends the range to show a coordinated system of erosion-control measures applied over large fields or an entire farm.

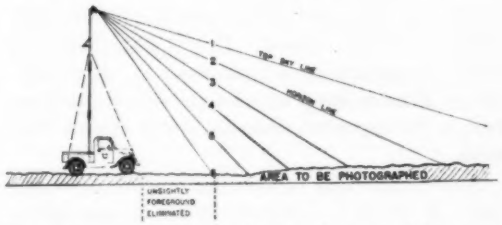


Figure 1.—A correct angle for photographing terraced fields or strip-crop areas. Clear focus, with unobstructed vision, is assured.

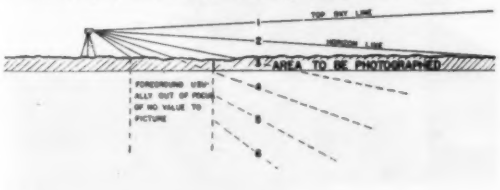
Assuming that the photographer won't risk his neck and camera by climbing trees to attain desired elevation, two major items of equipment are necessary for the job—a light pick-up truck, and a ladder properly mounted and anchored on the truck. The ladder must fold down to a height of 11 feet to pass under viaducts.

A Ladder on a Truck

Orin S. Welch, regional photographer in the Southeast, devised the ladder mounted on the truck shown in the accompanying illustrations.

Figures 1 and 2 show the desirability of taking pictures of erosion-control measures from an elevated position. Elevation provides the correct angle for taking photographs of broad areas, entire terraced fields, or strip crops. In this manner objects to be photographed are brought within the range of vision. Figure 2 shows the difficulty encountered in attempting to photograph large areas with the camera at tripod height. Unsightly foreground detracts from the artistic value of the resulting photograph and the scope of the picture is reduced greatly.

Figure 2.—An incorrect angle for photographing terraced fields or strip-crop areas. The camera is set to the same horizon line as in the other diagram, but due to its low position this line travels almost parallel with the surface of the land.



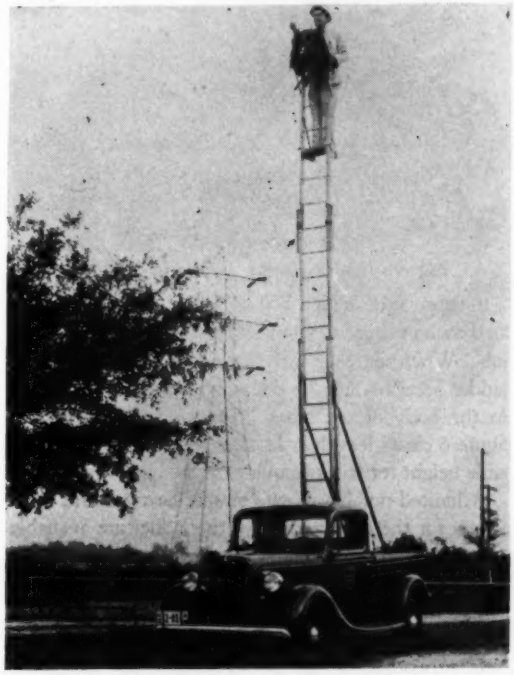


Figure 3.—Taking the picture.

Cables Stabilize Ladder

Figure 3 shows the truck and ladder equipment in operating position. Six wire cables are used to stabilize the ladder. Two are attached to the front bumper, two to the rear end of the truck body, and one to each side of the body. The cables are permanently attached to the ladder. When the ladder is folded down they are packed inside the truck body.

When the photographer is ready to drive to the next scene, he folds the ladder down. Figure 4 shows the method of raising and lowering with a piece of 2-inch gas pipe and crank to which wire cables are connected with the ladder. Turning the crank raises or lowers the ladder.

Figure 4.—Raising or lowering the ladder.

In figure 5 the ladder is being folded into the position as shown in figure 6, the position for travel to the next job. When moving any considerable distance the ladder sections may be dismantled easily and carried in the body of the truck. The ladder as shown in figure 6 clears less than 11 feet, the maximum permissible height for trucks moving on the highways.

A limited number of sets of specifications and blueprints for the construction of the ladder are available upon application to G. A. Barnes, in charge of the Section of Information. The total cost of all materials is less than $25. It can be constructed by two good workmen in 1 day. The job explained in this article was supervised by R. L. Stribling, chief warehouse mechanic, at Spartanburg, S. C.

Breadth Increased

Elevation brings into view a broader and deeper area. The breadth of the area may be increased still more by using the 5 by 7 camera now in use by the Soil Conservation Service, as a substitute for a circuit camera.

From the photographic ladder or from the ground panoramic views may be taken with this regular equipment.

To do this job care must be exercised in focusing the camera, with the tripod perfectly level. Determine the breadth of the area by swinging the camera, observing the scene as it appears on the ground glass.

Select the first position for the camera; mark the side of the tripod base to correspond with a designated point on the camera frame. Next look through the ground glass and move the camera to the second position allowing a small margin of the scene to overlap. About one-fourth inch is sufficient. Mark the point on the tripod to correspond with the point on the camera frame as before. The distance to be marked off for the third and subsequent scenes has now been determined. Always tighten the tripod screw before making an exposure and loosen it slightly before moving the camera to the next position.

Arrange the pivot of the camera to place it in position directly below the lens. This aids in obtaining a more perfect alignment for matching scenes in the foreground.

When to Take Pictures

The best views are made in early morning or late afternoon sunlight during the summer months. The midday sun gives too much overhead light, too much glare, not enough shadow. This is particularly true when photographing terraced fields or strip crops. Deep gullies or steep hillsides are subjects that can best be photographed when the sun is directly overhead.

Avoid direct back or front lighting whenever possible. If the lens is properly shaded a front light is preferable to light from the rear provided there is no better choice.

Panoramic Views

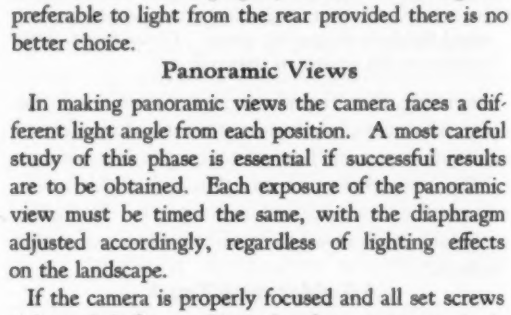
In making panoramic views the camera faces a different light angle from each position. A most careful study of this phase is essential if successful results are to be obtained. Each exposure of the panoramic view must be timed the same, with the diaphragm adjusted accordingly, regardless of lighting effects on the landscape.

If the camera is properly focused and all set screws tightened before making the first exposure, it is unnecessary to make further adjustments other than tightening the tripod screw and operating the shutter to complete the panorama.

Film packs are preferable for making panoramic views. They are compact and the job requires less time, an important feature when the ladder is being used.

(Continued on p. 35)

Figure 5.—Folding the ladder into position.



AN EXPERIENCE WITH BLACK LOCUSTS

A Muskingum County, Ohio, farmer, John Newell, knows from personal experience the value of black-locust trees in the control of soil erosion. Not only have black locusts reclaimed gullied areas on his farm but for a quarter of a century they have yielded him a profit from the sale of posts.

Forty-five years ago there was a natural black-locust grove on the Newell place, then owned by his father. The grove was cleared and the land was farmed for many years. At the time of clearing, the Newell boys planted "a couple of armfulls of locust sprouts" near the bottom of some bad gullies. They were planted in typical Ohio Muskingum silt loam and the area had no special preparation. The planting was done against the advice of the elder Mr. Newell, who didn't expect them to grow.

But they did grow and from the original plantings spread completely across the gullied area. From this original planting John Newell has been cutting posts for the last quarter century. He has sold posts every year for from 25 cents to 45 cents each. Two years ago Newell cut 165 posts and netted $41.25 for his trouble. During the most recent winter he cut a similar number of posts from three aged trees.

"They grow fast", Newell said, "and the nice part of it is they stop the gully washing. The first thing to grow is weeds, then the leaf litter begins to cover the ground. Then it isn't long until bluegrass comes in."

Foresters who have visited Newell's woodlands also note that other species of trees—having greater value from the standpoint of timber production—are getting a start.

Indication of extent of extreme erosion on the Newell farm in January 1935. Before being planted to black locust sprouts, this area was eroded down to the subsoil and gullies had formed from 3 to 6 feet deep. At the time this picture was made the locusts had taken root in the bottoms of the gullies and were spreading to the ridges between. Leaf litter and grass were serving to prevent further excessive losses of soil.

By May 1936 Canadian bluegrass had voluntarily covered the area, definitely controlling erosion where raw gullies had formerly existed.

LESPEDEZA'S VALUE SHOWN BY EXPERIMENT

The value of rotations is illustrated by results of experiments with cotton and lespedeza conducted by the Soil Conservation Service in cooperation with the South Carolina Experiment Station. Results were obtained from 33 plots scattered over 11 farms.

Each plot was divided into two equal parts. One part was sown to lespedeza and the other half planted to cotton. The following spring lespedeza was turned under and the entire area planted to cotton. All of the plots received the same tillage and fertilizer treatment.

Erosion Reduced

Lespedeza cut down erosion losses. Every thousand gallons of run-off water from terraces in the cotton land washed away 8.3 pounds of soil, whereas the same amount of water from the lespedeza land carried 2.5 pounds, or less than one-third as much soil. Furthermore the total run-off from the cotton land amounted to more than 17 percent of the total rainfall, while on the lespedeza all but 10 percent of the total rainfall was absorbed into the soil where it fell.

Seed cotton yields on the lespedeza land averaged 939 pounds per acre. Where cotton followed cotton the yield averaged 583 pounds. Lespedeza increased the yield, therefore, an average of 356 pounds per acre or 61 percent.

Interpreting these results, scientists conducting the experiments found that the cotton land lost an average of 17 tons of soil while the area in lespedeza lost slightly more than 1 ton per acre.

GREEN ROADSIDES MAKE STABLE HIGHWAYS

By George W. Hood [1]

Erosion control on highways means, first of all, grades where vegetation will grow. Grasses take kindly to easy, continuous slopes. And on such slopes power mowers may be used and maintenance costs held down thereby.

Trees are in order on many steeper slopes and banks. All slopes should be gently rounded, and the waterways should be made wide and shallow.

Grasses Prevent Cutting

Cutting does not usually occur where grasses are firmly established and where the waterways are wide so that the water is spread out in a thin sheet.

When we discuss vegetation, we naturally include alfalfa and other vegetation not of the true grass type which, in addition to suitable grass mixtures, often make an excellent ground cover.

[1] Regional forester, Soil Conservation Service, Salina, Kansas.

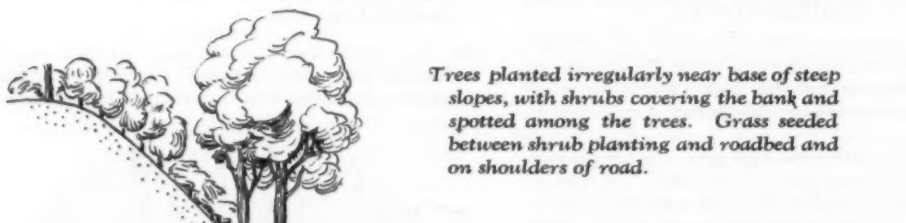
Deep cuts and high banks call for the use of shrubs or woody vines, with opportunity now and then for the planting of trees as a further measure.

Locating Inlet Culverts

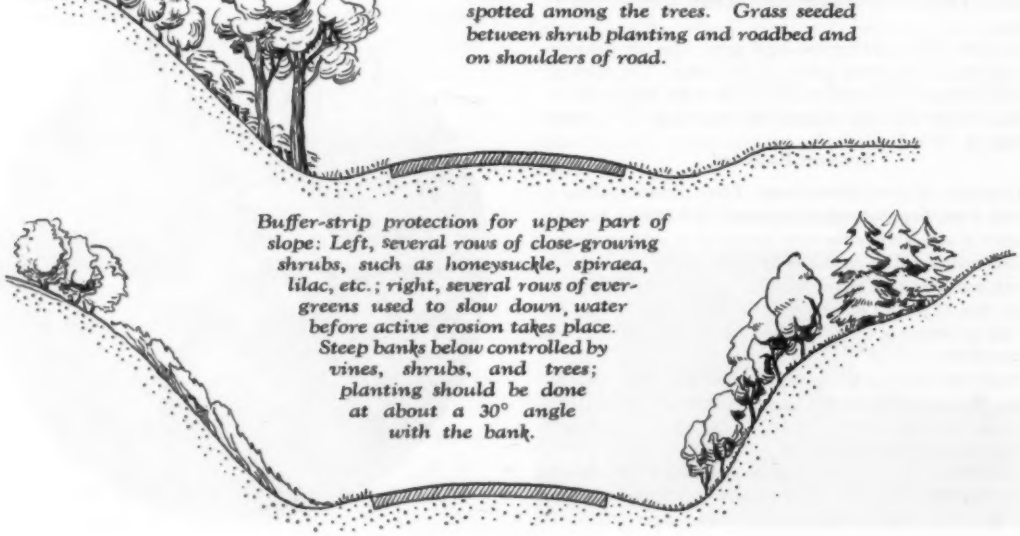
Inlet culverts should be at least as high as the adjoining land, to prevent side gullying along the road and cutting back into adjoining fields. Drop inlets are often essential, if conditions necessary for the establishment of vegetation are to be provided. Neither grass nor woody vegetation can be established or maintained when there is washing or cutting of the soil.

The type of woody vegetation selected should conform closely to the natural growth in that particular locality. Many cultivated trees and shrubs are adaptable for such planting, but their selection should be carefully made.

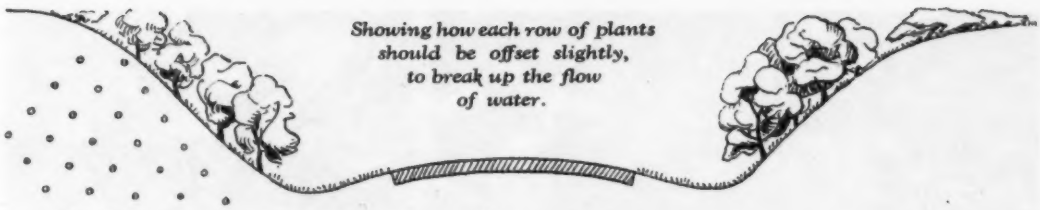
Left, proper roadside grade, permitting establishment of grass mat. Right, improper grade whereon it is impossible to develop a grass covering.



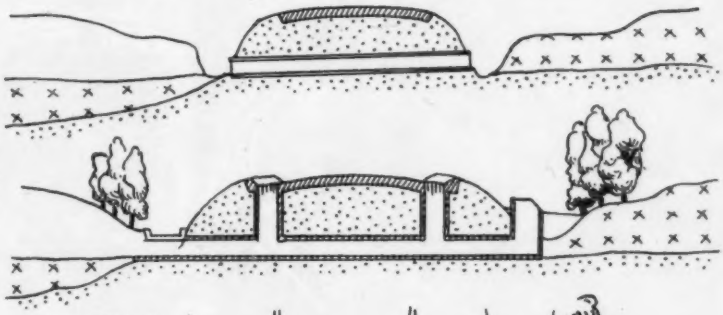
Trees planted irregularly near base of steep slopes, with shrubs covering the bank and spotted among the trees. Grass seeded between shrub planting and roadbed and on shoulders of road.



Buffer-strip protection for upper part of slope: Left, several rows of close-growing shrubs, such as honeysuckle, spiraea, lilac, etc.; right, several rows of evergreens used to slow down water before active erosion takes place. Steep banks below controlled by vines, shrubs, and trees; planting should be done at about a 30° angle with the bank.

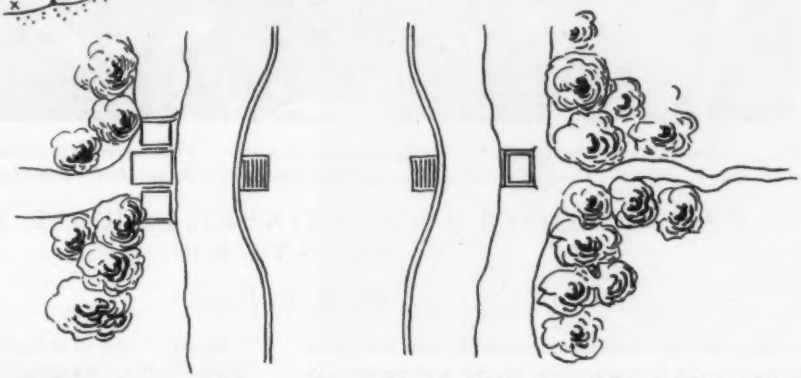


Showing how each row of plants should be offset slightly, to break up the flow of water.



Above—The usual type of pipe permitting loss of soil, as indicated by "x."

Below—The drop-inlet type, which saves soil, as indicated by "x," together with widening of roadway over culvert and grating to carry water from road into outlet. Ditch checkers are used on the lower side, and buffer strips stabilize soil deposit.



Heavy Seeding

In planting either grass or shrubs, the seeding should be heavy and the planting close, so that quick coverage will develop. Grass seeding should be heavier than normally used for general field plantings, depending, of course, upon the varying local conditions. Ground-cover shrubs should be set 2 or 3 feet apart, depending upon the steepness of the slope, the fertility of the land, the care they are to receive, and the ease with which they can be established. On steep banks rows of shrubs should be planted at right angles to the flow of the water, and each row offset several inches from the adjacent row, so that, when completed, the water can find no direct passage to the bottom.

An Eye for Beauty

Care should be used in plantings. A combination of shrubs or woody plants should be made with an eye to beautifying the highways as well as stabilizing them. Mass plantings of a single suitable species will sometimes be satisfactory and in keeping with the general surroundings; in other places mixed plantings of two or three species are to be favored. Vines, such as ampelopsis, Japan honeysuckle, or matrimony-vine, often make the best and most appropriate ground cover, and blend with the surrounding vegetation. Other sites lend themselves well to a mass planting of low, compact shrub growth, such as develops from dwarf sumac, Indian currant, or native snowberry.

Triangular areas at the junction of two roads may be made attractive at the same time that erosion is checked. Properly graded and planted, such areas will serve as recreation spots. They should be grassed and planted to trees. If the size of the areas warrant, shrubs may be introduced—low-growing species which will not obstruct the view.

The principal bulwark of woodland against erosion by water. This sievelike organic blanket takes the surface run out of water and causes the water to percolate slowly into the soil.

FARM WOODLAND: CONSERVER OF SOIL AND MOISTURE[1]

By A. E. Fivaz [2]

Early settlers commented excitedly on the dense forests in the humid regions, on the high fertility of the soil, and on the abundance of fresh-water springs and the clearness of the streams in this wooded wilderness. They saw little or no accelerated erosion. Rains fell and snows melted, there was high water but floods attaining the intensity and frequency of those of today were unknown. In times of drought, springs and streams continued to flow from the great soil reservoirs beneath the trees. The abundant ground water and the rich soil provide for a lush growth of vegetation and, in turn, the trees, shrubs, and other woodland plants covered and held the soil against erosion, fostered the storage of water, and constantly contributed to the enrichment of soil. This nearly perfect balance, unfortunately, now has been disrupted over most of the original forest area.

Above us and all around us in the virgin woods are leaves, twigs, branches, and stems, which expose innumerable little surfaces aggregating an area several times greater than that of the ground beneath. This loosely thatched roof, often a hundred feet or more in thickness, is the first line of protection against surficial run-off and the soil erosion it causes. Driving rains beat upon it but below it the falling water slides meekly down the stems or drips weakly to the ground. As much as half an inch of rainfall may be completely intercepted by this thatch.

Dr. Hans Burger, a pioneer in the study of the partnership of wood and water in Switzerland, states, "After many examinations it is found that the trees of a forest, according to the species of tree and the density of the forest, will hold back 20 to 40 percent of the rainfall, so that it never reaches the ground but evaporates and increases the humidity of the air."

The main bulwarks of woodland against erosion, however, are just beneath our feet. At the surface is the litter and humus, a complete blanket of organic

[1] This is the second article in a series which opened in the July number with The Place of the Forester in Soil Conservation, by John F. Preston.

[2] Forester, Woodland Section, Soil Conservation Service.

material such as leaves and twigs in various stages of disintegration. It is not a very smooth blanket but rather an endless series of little depressions. These catch the water that penetrates the thatched roof overhead and restrain it from running away on the surface. The blanket is like a sieve, and the water filters downward through it to the soil beneath. This all-important organic mantle influences the soil in several ways, making it more permeable to the waters that filter through the blanket. The surface of the soil is kept moist and absorbent even in winter when exposed soil is deeply frozen. Organic acids in the humus react to make the soil more porous, giving it what is known as tilth. Furthermore the litter and humus form the principal habitat for a vast population of organisms important to soil building, soil holding, and water storing.

We recognize the forest carpet and the soil that blends into it as the home of rodents, earthworms, ants, larvae of locusts, and other insects, all of which aid in water movement and storage. But, as Dr. Arthur Paul Jacot, of the Appalachian Forest Experiment Station, has stated, "this assortment of odds and ends of the animal kingdom are local in their effects as compared to that of the minute segmented animals (arthropods) so numerous and generally distributed in organic soils as to be of outstanding importance in making and keeping the soil full of minute channels which make it possible for rain water to enter it instead of running off the surface. The intricate, ramifying patterns which these microarthropods establish are of far greater importance in water percolation than mechanical soil porosity—as evidenced in soil which has been so eroded as to have lost this animate layer." Through the agency of these innumerable microanimals, roots and rootlets that have completed their periods of living service and have been softened by fungi are hollowed out to the more resistant bark and became water pipes, rapidly and safely conveying huge quantities of water to the deeper reaches of the soil.

A Subcarpet

Woodland cover has still another line of defense against soil erosion. The intricately woven mass of living roots forms a subcarpet beneath the forest litter with extensions deep into the mineral soil, binding the humus and soil into a mat or a ball that resists erosion. While this line of defense is important only on the steeper slopes in a virgin woodland, it is elsewhere of primary importance when the erosion control efficiency of the forest floor has been seriously reduced by man.

The aerial portion of the trees and shrubs form a loosely-thatched roof, woodland's first line of defense against soil erosion.

Thus, there is relatively little surficial run-off from a virgin woodland area, and, of course, no soil erosion. Water not evaporated or utilized by the vegetation moves slowly through the soil to feed springs and streams or to replenish deeper stores. With this perfect association of vegetation, soil, and water functioning in the presence of abundant air and sunlight, each associate is preserved and renewed to perpetuity.

Soil Losses Compared

The relative efficiency of woodland cover for soil and moisture conservation as compared with various other uses of moderately sloping land has been demonstrated at several of the erosion-control experimental

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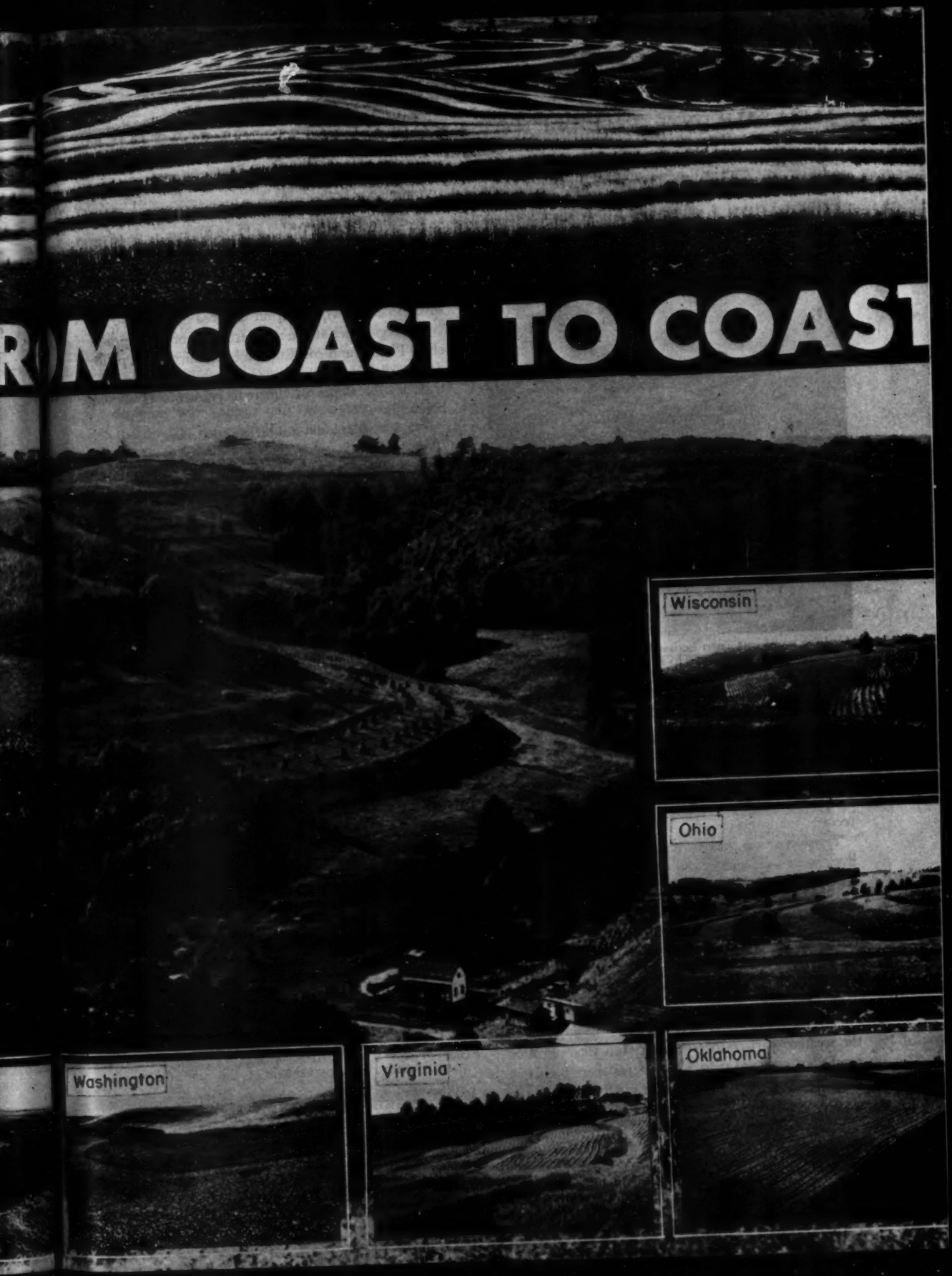
South Carolina
STRIP CROPPING FR
West Virginia
California
Kansas
Ohio
Texas
Oklahoma


M COAST TO COAST
Wisconsin
Ohio
Washington
Virginia
Oklahoma

MEASURING THE VENGEANCE OF A SINGLE STORM

By Henry R. Adams [1]

Gullies were cut into bedrock, and large rock slabs were carried onto the fields below.

Highways, railroads, bridges, buildings, and soil within a strip in central and southern New York 20 miles wide and 100 miles long felt the impact of a record-breaking rain on July 7 and 8, 1935.

At Ithaca, close to the center of disturbance, the precipitation amounted to 8.12 inches in 36 hours—5.46 inches in 12 hours. This topped all previous records for intensity.

Transportation was in many places disrupted, 50 lives were lost, and in the wake of the disaster was an enormous erosion damage, with toposil and even growing crops washed from hillsides and with 20-foot gullies drilled over night. Some of these gullies penetrated several feet into the bedrock of shale and sandstone. Sand, gravel, and boulders were strewn over many a formerly productive field to a depth of a foot or more.

The Cohocton River demonstration project lies in the western part of the storm-stricken area. Erosion conditions on more than 30,000 acres there had been studied and mapped previously. After the storm, nine typical farms, comprising an area of 1,560 acres, were remapped by the same men.[2] While it is improbable that this area is representative of the whole storm belt, a comparison of conditions before and after the storm gives considerable information concerning several factors which permit the loss of soil.

The region lies at the northern edge of the Appalachian Plateau and consists of a high, fairly level plain, deeply dissected by steep-walled valleys. The distribution of slopes of different gradients is shown herewith.

Distribution of slopes over 1,560 acres

Percent slope:	*Percent of area*
0–5	16.9
5–15	37.5
15–25	14.9
25–35	15.9
35	14.6

General Farming Prevails

In most of southern New York, dairying is the principal agricultural enterprise, but here general farming is the usual thing, with potatoes as the chief cash crop. A 4-year rotation of potatoes, oats, and 2 years of hay is commonly followed. The acreage of clean-cultivated crops is higher than in most of southern New York. The approximate distribution of crops over the 1,560 acres studied is shown as follows:

Distribution of crops over 1,560 acres

Crop:	*Percent o area*
Meadow	28.5
Pasture	24.1
Small grain	16.7
Buckwheat	1.5
Row crops	15.0
Forest	8.0
Idle	5.0
Farmstead and orchard	1.1

This indicates that 33.2 percent of the land was plowed only a few weeks or a few months before the storm, and that 15 percent was planted to clean cultivated crops. More than three-quarters of the crop land, including meadows, was on slopes of less than 25 percent gradient, while nearly one-half of the pasture and about two-thirds of the idle and forest

[1] The author is soil scientist, Soil Conservation Service, Norwich, N. Y.

[2] The mapping in this study was done by W. W. Reitz and H. C. Knoblauch.

land were on slopes steeper than 25 percent. Much of the pasture and idle land is on fields which were under cultivation at one time, but as the fertility decreased, due to erosion and other causes, they were dropped from cultivation. As a result of this unproductive condition, the vegetative cover over much of this land is poor, thin, and weedy.

Gullying the Index

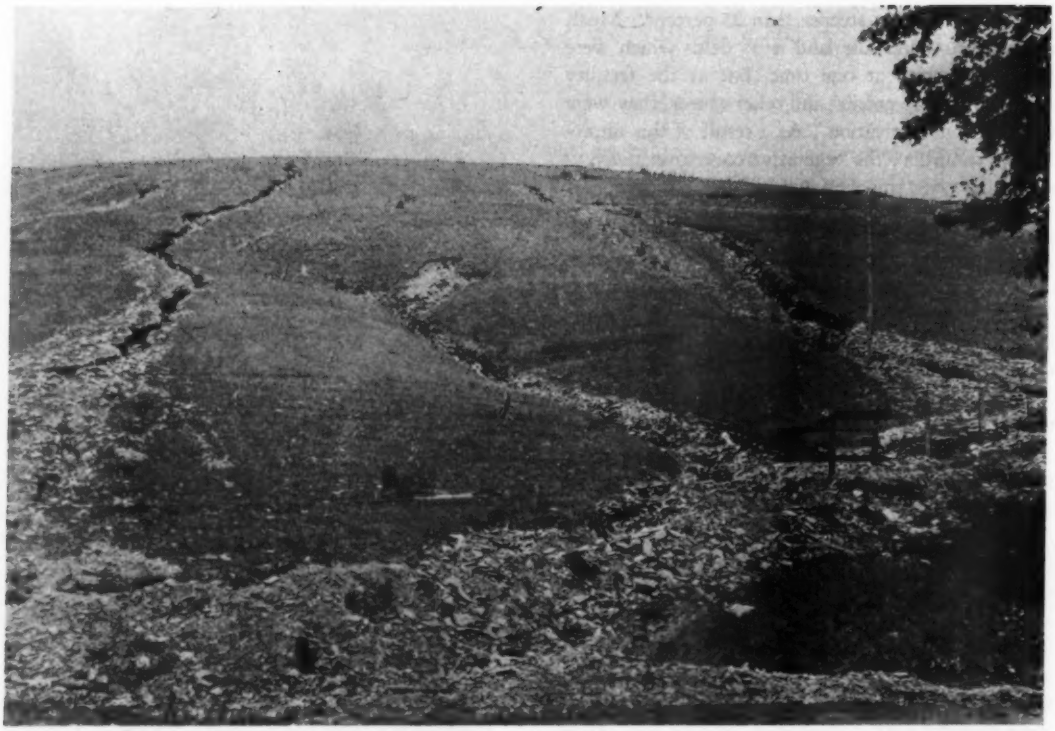
In comparing erosion conditions before and after the storm, gullying was taken as the basis, since it is difficult to evaluate a change in sheet-erosion conditions. It is safe to assume, however, that increased sheet erosion accompanied the gullying and was spread over a comparably large area. The term "gully" in this mapping was applied only to channels which were too deep to be erased by ordinary tillage operations. Rills a few inches deep were classified with sheet erosion.

Of the 1,560 acres studied, 252, or 16 percent, contained new gullies, and on 100 of these (6.4 percent of the total area) these gullies were less than 100 feet apart, or at the rate of more than three to the acre. The storm had deepened old gullies or had cut new gullies deep enough to prevent crossing with ordinary farm implements on 98 acres. Twenty-nine acres were covered with a deposition of rock and gravel, and on 15 acres this deposition was over 9 inches deep.

Gullies up to 20 feet in depth developed overnight.

Twelve acres were covered with silt deposits, which on 2 acres were more than 2 feet deep.

Buckwheat provided little protection to the soil when flanked on the up-side by cultivated crops. This is shown conclusively in this view of a slope strip cropped in oats, corn, mixed meadow, potatoes, buckwheat, and grassy meadow.



Pastures suffered severely during the storm.

It has been generally recognized that a dense cover of close-growing vegetation is an effective natural protection against erosion, and this is borne out by these observations. Forest cover permitted the least erosion and meadow was next. Only 3.9 percent of the meadowland showed the presence of new gullies, while over 15 times that much land in row crops was affected. The acreage of buckwheat was too small to give conclusive evidence, but the results verify other observations that this crop offers little resistance to erosion.

The fact that small grains, seeded only a few months before the storm provided more protection to the land than was given by pasture with a permanent sod cover can be explained by the poor, thin cover of many of the unimproved pastures. Even if the small-grain crops were not fertilized, they were usually following a crop to which a fair amount of fertilizer had been applied. In preventing the formation of frequent gullies, the pasture sod was more effective than the small grains, and the difference was not great in the development of deep gullies.

Much of both pasture and idle land is on run-down, uncared for fields, and about 25 percent of each was gullied before the storm. Nearly three-quarters of the idle land is on slopes steeper than 25 percent, while only about one-half of the pasture is on such slopes. But for some reason, possibly the effect of grazing, the water running over the pastures cut a large percent of the land with new gullies, while on the idle land the water apparently concentrated in the old gullies and cut them deeper, with little damage to the land between them.

In this instance steepness does not appear to have been a dominant factor in erosion on pastures, since over three-quarters of the gullying occurred on that half of the pastures occupying slopes of less than 25 percent. The reason evidently was due to the poor cover which had developed on a few fields of 20 acres or more, largely on slopes of less than 15 percent.

It was noted that gullying occurred in a smaller percent of the pasture fields than anywhere else except meadow, but that the average area affected when a field did gully was much greater in pastures than elsewhere.

Although steepness of slope apparently was of minor importance in pastures, it was a factor of great importance in erosion as a whole. Eighty-two and a half per-

cent of the deep gullying occurred on slopes steeper than 25 percent. A comparison of gullying by slopes on meadows and clean-cultivated fields offers a sharp contrast in erosion over a wide range of slopes.

Gully erosion by slopes on meadow and clean-cultivated fields

Slope	Meadow	Row crops
Percent	*Percent*	*Percent*
0– 5	0	23.6
5–15	4.5	60.1
15–25	6.1	75.9
25–35	11.5	66.9
35	13.3	92.8

The rapid increase in the amount of erosion as the slope increases is readily seen. It can also be seen that adequate protection must be given to land growing clean-cultivated crops even on the gentler slopes.

Strip Cropping

Other observations following the storm showed that good protection was given by an arrangement of fields so that the clean-cultivated crops were in strips extending across the slope between fields of close-growing crops. This practice, which is commonly known as "strip cropping", was effective on slopes up to 25 percent or more. However, it is obvious that greater protection is necessary as the steepness of slope increases and that there is a slope limit, depending on soil, climate, and other conditions, above which it is not economical or practical to attempt to grow clean-cultivated crops and still provide adequate protection.

Over 90 percent of the deposition of sand, gravel, or silt occurred on meadows, pastures, and idle land—fields which were protected by a sod cover. Numerous observations immediately after the storm showed that the grass cover was laid flat by the rushing water and formed a carpet which not only slowed up the water so that it dropped its load, but which also protected the soil beneath from any erosion.

Conclusions

Studies of erosion caused by one severe storm show clearly that erosion is governed by type of soil, vegetative cover, and steepness of slope.

Although this storm was of abnormal severity, the region is subject to torrential summer rains, and its lessons are applicable to farming elsewhere.

The studies indicate that the best natural agent for protecting the soil from erosion is a dense cover of vegetation.

Maintenance of fertility on crop land and improvement of meadows and pastures are necessary to the production of adequate cover, which is of such great importance in an erosion-control program.

Strip cropping gives good protection when row crops must be grown.

Erosion increases rapidly as the steepness of slope increases, and it is much more difficult to prevent it on the steeper slopes.

It is possible to establish a slope limit, depending on soil, climate, and other conditions, above which it is neither economical nor practicable to attempt to grow clean-cultivated crops and still provide sufficient protection to the land.

Meadows and other close-growing crops not only prevent erosion on the land where grown, but they also catch and hold soil material which is being washed down from the land above.

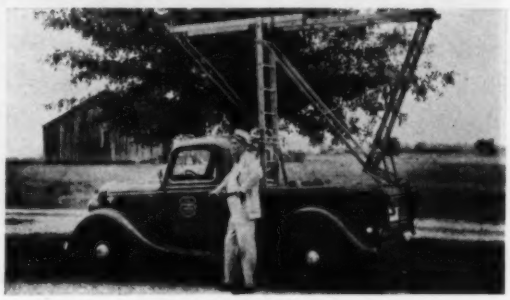


Figure 6.—Ready to go.

MAKING CAMERA EFFECTIVE

(Continued from p. 24)

Select the main point of interest to be photographed in the panorama then make as few exposures as necessary to record the scene. If two or three positions cover the subject there is no need for four or five The limit should be five. Views of two or three exposures are useful for certain types of publication; however, longer panoramas cannot be reproduced conveniently.

Five scenes covered by an 8½-inch lens embrace a greater area than when a longer focal lens is used. However, with the longer focal length lens more depth may be secured.

Prints may be made from the negatives in the ordinary way. Be sure to make the prints uniform, of the same shade and density to insure perfect matching. A practical method is to match the negatives in a printing frame first, and print as one print from paper cut to proper length. Thus, more even matching is assured and the laps and spliced joints avoided.

FARM WOODLAND : CONSERVER

(Continued from p. 29)

stations of the Soil Conservation Service. As against negligible run-off and soil loss amounts for woodlands and slightly greater but still negligible corresponding figures for grasslands, the annual run-off records range from 14 percent for good crop rotations to 30 or 35 percent for continuous row crops, and as much as 44 percent for fallow land. Soil losses range from 3 to 65 tons per acre per year for these land uses. It is indeed fortunate that there remain in our agricultural regions over 185,000,000 acres of farm woodlands.

Grazing of woodland areas may destroy the woodland cover, and on slopes such as this leads to the destruction of the soil.

These woodlands are a far cry, for the most part, from the virgin forests that once occupied their sites. Many acres of these woods are struggling on areas but recently abandoned and removed from cultivation as a result of erosion or soil depletion. The few years of tillage have destroyed the favorable soil structure that nature painstakingly built up over centuries, and dissipated the organic content of the soil so important to its moisture-retaining, erosion-resisting, and growth-favoring capacities.

The influences of tillage are well illustrated by the experience of Dr. C. A. Schenck, an internationally recognized forester, on an estate in North Carolina. Given the task of reforesting the many farm fields that made up the tract, Dr. Schenck observed the fine form and growth of important "climax" hardwoods in adjoining sites of the same soil type which had never been deforested, and he tried to reforest the fields with hardwoods. Many of the trees died and those that survived made so little growth that they could hardly compete with the weeds and grasses. The tilled soil, which but a few years before had had the structure and composition of that in the woods at the edge of the field, would no longer support the climax forest vegetation represented by the woods. Dr. Schenck turned to pines and spruces, more primitive species in nature's succession, and these have been successfully established. If these areas are undisturbed over the course of several rotations, the soil conditions essential to the climax hardwoods will be restored and the site will again be occupied by them. It is obviously better woodland economics to dedicate sites permanently to woodland use rather than to rotate woodland and tillage as we have usually done in the past.

The Evil of Burning

Our farm woodlands are frequently burned, either accidentally or intentionally under various barbaric theories arising from our forefathers' struggle to establish tillage in a wilderness. Fire works in several ways to reduce the effectiveness of woodland in conserving soil and moisture. The so-called "harmless" ground fires, intended to "clean up the woods," to "kill boll weevils", or to accomplish other legendary objectives, are especially damaging to the essential mantle of litter and humus. A single severe fire or repeated light burnings consume this organic material, decimate beneficial soil fauna, and materially increase run-off and erosion. Soil-erosion experiment station results indicate that annual burning of woodland increases run-off from 10 to 30 times and soil loss from 12 to 300 times.

Unwise use, exemplified here by cutting without provision for natural regeneration of the woodland cover, creates serious erosion hazards not only to the woodland site itself but also to good agricultural lands and watercourses below.

Fire destroys the seed and seedlings on which woodland renewal depends. When severe, it destroys mature trees, but in farm woodlands this is usually less of a factor than its unholy alliance with fungi. Rot-causing organisms enter the trees through basal fire scars and reduce or destroy the crop value of the affected trees.

Overgrazing Versus Profitable Grazing

In still another way are natural conditions in farm woodlands materially changed through unwise acts of man. Nearly three-fifths of these 185,000,000 acres are grazed by domestic animals. Except in certain limited areas of open woodland where grasses and trees form a congenial association, grazing is a double-barreled uneconomic practice. On the one hand, woodland pastures provide little more than bare subsistence grazing as contrasted to profitable grazing. The grass is sparse, scattered, and unpalatable, and actual measurement of changes in weight of stock forced to graze in woodlands indicate that the practice is economically unsound purely from the livestock standpoint. On the other hand, grazing causes cumulative damage to the woodland cover, ultimately resulting in its destruction. Increased run-off and erosion accompanies this damage.

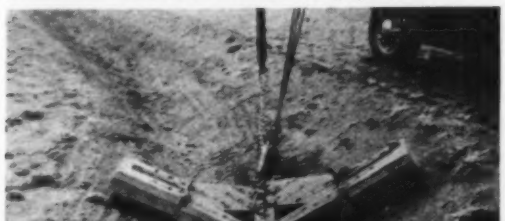
The browsing of foliage and "riding down" of saplings, especially hardwoods, soon eliminates the younger-age classes. By preventing natural reproduction in these types, grazing changes the lease of woodland on the site from a normally permanent one to a term lease, terminable at the maturity of the youngest tree—a maturity which is further hastened by other grazing influences adverse to tree growth. In practically all woodland types grazing animals cause openings in the protective forest canopy, which steadily increase in size. As a greater proportion of light reaches the forest floor, the organic mantle breaks down and inferior grasses and weeds increase. The soil is compacted by trampling, its structure is changed and it becomes much less permeable.

(Continued on p. 40)

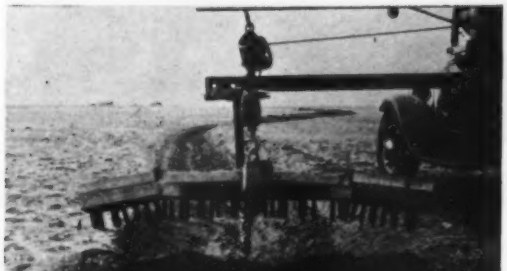
A DEVICE THAT FACILITATES SEEDING OF PASTURE TERRACES AND CONTOUR FURROWS

By Wayne Austin [1]

Pasture terraces and many of the larger contour furrows in Colorado are made with either a road grader or a disk plow. These implements leave the sides of the terraces below the ground level very smooth and hard. It is useless to broadcast seed in this type of furrow until some sort of seedbed can be prepared.



Ready to begin work.



Up and over a cross dam.

Reharrowing a pasture terrace after it has been seeded.

A brush drag first was tried but without success. The sides of the furrows were so hard and smooth that the seed was brushed to the bottom of the ditch, where it was left without any covering. When the wind blew, most of the seed was scooped out of the furrow, scattered over the prairie and lost, or was pocketed in protected places.

A flexible-winged, V-type harrow was built for use in these furrows. The next problem was how to pull it and how to get it over the cross dams that are built in the terraces every 80 to 100 feet. This was accomplished by tying two 15-foot railroad irons across the bed of a truck. The harrow was fastened to the forward iron by means of a log chain. The rear rail was placed directly over the harrow, and a block and tackle was fastened to the center of the harrow. A man riding on the bed of the truck pulls the rope at the proper time, and this lifts the harrow over the cross dams as they are reached. The furrows are first harrowed, seeded with the broadcaster, and then reharrowed.

This type of harrow prepares a very good seed bed and yet does not destroy the structures. The seed is sufficiently covered with soil by reharrowing to protect it from the wind and give it a chance to germinate. One truck and two men can harrow 30 to 40 miles of contour per day with this equipment.

The accompanying photographs show the harrow at work on pasture terraces in the Black Squirrel Creek area.

[1] Assistant agronomist, Soil Conservation Service.

Index Available

An index covering Volume I of Soil Conservation (August 1935 to June 1936, inclusive) is now ready for distribution on a restricted basis.

Crider Honored

F. J. Crider, head of soil conservation nurseries, has been awarded the degree of Doctor of Science by the University of Arizona. This was in recognition of Dr. Crider's leadership in the development of horticultural sciences in the Southwest, his scholarship in plant nutrition, and his contributions as teacher, research worker and regent of the university.

President Roosevelt has appointed H. H. Bennett, Chief of the Service; Morris L. Cooke, Administrator of the Rural Electrification Administration; and F. A. Silcox, Chief of the Forest Service, as a special committee to call a conference of experts from the United States and foreign countries in Washington, September 22 and 23.

The purpose of the conference is to assemble data on "up-stream" engineering in relation to flood control and land conservation.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

SOUTHERN REGIONS OF THE UNITED STATES. By Howard W. Odum. 1936.

A work such as this, about the South, out of the South, prepared by a man who for many years has labored for the advancement of southern interests, should and will have far-reaching influence not only in the region covered by the volume but in the future of the Nation's readjustments as well. Dr. Odum, of the University of North Carolina, here presents an extraordinarily detailed and realistic picture of the southern United States, formerly designated as the South, now characterized in this work as southern regions, clearly differentiated into the older Southeast and the emerging new Southwest. Although in the indexes is to be found vast comparative data involving other regions and the United States as a whole, the book is, essentially, a book of the Southeast.

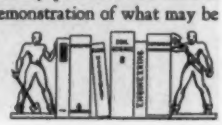
Can the southern regions, set in the midst of a superabundance of nature's wealth, abounding in multiple resources of geographic variety, of human stock, and of cultural tradition, occupying strategic positions within the Nation and in relation to the nations of the world, continue to feature deficiency, marginality and immaturity, framed in isolated sections separate from the Nation, except as a peculiar phenomenon of cultural pathology? With a wealth of inventory of fact and actualities, with data on industry and agrarian resources, technology, deficiency, and waste, human culture and institutions, the author answers these queries, working toward and including a study on regional planning for southern United States. It might seem to the casual reader that Dr. Odum had written an unsympathetic book; on the contrary it has the tone of urgency—it shows us the southern regions as they are, almost, it might be said, to the last gully, so that out of this period of reconstruction there may come something, at least of permanent value to the South and to the Nation.

Naturally, the disturbing story of the South's eroded soils, misuse and abuse of rainfall, rivers, and streams, occupies an important place in the sections of the book which treat of deficiency and waste. With the authority of the man who knows his regions and need not theorize, Dr. Odum states baldly that soil waste in southern regions "is measured in terms of more than half of all the Nation's erosion toll." Using the estimates of the Chief of the Soil Conservation Service, H. H. Bennett, who for many years has surveyed, sampled, and studied the soils of the Southern States, Dr. Odum presents the tragic picture of topsoil depletion in the Carolinas, Georgia, Alabama, Louisiana, Arkansas, Tennessee, and Virginia. That there should be a single county in the South Carolina piedmont where 277,000 acres of land have been seriously affected by erosion, is in the fact itself an urgent plea to right-about and face the issue of the South's urgent need for planned conservation and reconstruction.

Another factor which has caused large waste of arable land in southern regions—deposition of erosional debris over alluvial bottoms—receives treatment. An immense aggregate area of formerly rich bottom land has been affected by frequent overflows from streams with choked channels, and by deposition of sand and gravel and other material washed down from the hillsides, covering the soil and rendering cultivation precarious, if not impossible. As to the single-crop system of the South, followed persistantly throughout the generations, Dr. Odum points to cold figures representing annual purchase by the Southeast of 5½ million tons of commercial fertilizer as compared with all the rest of the Nation's 2½ million tons. He tells of "vast gullies and gulches, wagon-wide and tree-deep, spotty hillsides, and great stretches of fields marred like some battlefield" and a stupendous drain on soil elements essential to plant growth by deficiency of agricultural methods, which if continued would make the region impotent for agrarian culture or to supply wealth of any kind adequate to support industry and mercantile interests.

In a masterful discussion of the South as an agrarian country special consideration is given the possibilities of subregional classifications in the light of present-day problems. A vast amount of information and data is given in text and indices to show the complex picture in its manifold detail. Herein the reader-student is brought face to face with the figures which depict the exigencies of farm life on millions of small and poorly equipped farms; with the hazards of financing, high interest and poor credit; with soil erosion and depleted natural resources; with the picture of a million prospective squatters and migrants; with lowered standards of living and social deficiency. Within this specialized examination of the subregions the subject of farm areas is considered in the light of regional variations of basic factors—geography, soil, climate, topography, general cultural and folk-institutional ways, labor and supply, agricultural mechanization, markets and transportation, cooperative agencies. And herein is included a study of the 1,100,000 "cotton" farms of the Southeast, backed by fact and figure, to the effect that at the present rate of soil depletion the Southeast cannot continue to produce the present maximum of this crop without further and inevitable destruction of resources.

As this study of the cotton outlook reveals the urgency for a substitute economy which will effectively merge economic and social diversity with cotton economy, Dr. Odum passes swiftly and expediently to an exploratory survey of the southern uplands as regions suitable for an expansive dairying industry. Here the author finds hope for the Southeast, saying: "These studies of new prospects for dairying are fundamental to the whole question of agricultural reconstruction and agrarian life in the South. It is, indeed, through the very realistic, practical, subregion by subregion approach that the picture must be painted or success attained rather than through the ideological motivation for an abstract agrarian culture. To use Mississippi as an example, at least half the people now live on tenant farms. Those counties having the largest ratios of tenancy also show the largest ratios of illiteracy and other measured deficiencies, yet show the smallest sized value of all farm products sold. This does not mean the highest ratio of vegetables raised in farm gardens, or of chickens and eggs produced, or dairy cows on farms; but crops sold for cash, where in this case the cash does not go to the farm tenant. In the statistics for these four aspects of farm life—dairying, dairy cows on farms, farm vegetables grown in farm gardens, poultry produced and used at home—may be found experimental demonstration of what may be accomplished through the reconstruction of farm life. Of special importance is the new program of County-State-Federal cooperation in soil



erosion and conservation of land." Further, Dr. Odum writes: "Nevertheless, the dream of a revitalized agrarian culture in the Southeast must be given the fullest possible consideration, both because of inherent possibilities and because of the case which is being made for it on many sides."

The first general conclusion drawn from this extensive volume is that the task of planning the safe and sure future for the Southeast is an extraordinarily difficult one, but that all the elements for success are present provided they can be focused in the right ways and combinations. On the other hand, it is evident that the writer visions from the wealth of evidence set forth that unless there is a definite change in regional economy there will be retrogression in agriculture, in industry, and in general culture and institutions. It is to be hoped that, when the year of midcentury rolls round, those who labor and hope and plan for the South may turn for comparison, and with pride of achievement, to this vivid and detailed southern picture of the year 1936.

FARM WOODLAND: CONSERVER

(Continued from p. 37)

Dr. Burger states, "Many hundreds of experiments, carried out all over Switzerland, show that pasture lands are almost nonporous. Three to five times better is the permeable earth of the hayfield and ten to thirty times better that of good, uncultivated forest floors."

The roots of neighboring trees, no longer adequately protected by litter and humus, and influenced by the soil changes, exposure, and direct trampling, are more readily susceptible to damage by drought. Cooperative studies by the Purdue University Agricultural Experiment Station and the Central States Forest Experiment Station show that, as a result of grazing, the growth and vitality of large trees are affected. Soon they become stag-headed, the openings in the canopy get larger, and eventually the woodland is no more.

Ground fires destroy the organic blanket laid down by woodland cover and materially reduce protection against excessive run-off and soil erosion.

Finally, the sound natural conditions of our farm woodlands have been materially altered by unwise, unthoughtful, or greedy cutting. Nature does not deny man the use of trees, since trees have a relatively definite natural span of life and can reproduce their kind. It is only when man cuts in ignorance or disregard of natural processes that Nature fails to reproduce woodland as good if not better than that removed. Cutting without benefit of silviculture has denuded some sites and has so altered the composition of woodlands on others, as to create problems almost impossible of early economic solution and generally has lowered the productive capacity of farm woodlands. All of these conditions have a direct bearing on soil and moisture conservation. The permanency of woodland cover, so important to soil and moisture conservation, is primarily dependent on its economic value as a producer of fuel and lumber. When opportunity for income diminishes or disappears, woodland cover soon gives way to uses which are more immediately profitable but hasten the process of erosion.

Farm woodlands, even in their present deplorable condition, are important bulwarks of soil and moisture conservation, and their perpetuation and more effective functioning are much to be desired. This can be brought about only by a complete overhauling of practices with respect to their management, protection, and use.

Under agreements between farmers and the Soil Conservation Service, there are scheduled for construction during the next 3 years more than 36,000 miles of farm terracing, or enough to make 14 terraces from New York City to Los Angeles.

Especially on moderate slopes of deep, porous soil are terraces valuable, but they are only one part of erosion control, and must be supplemented by ample vegetation, proper cropping and tillage practices, and increased planting of soil-binding crops.

U. S. GOVERNMENT PRINTING OFFICE: 1936